

# Energy Literacy

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**Work In Progress : Draft : March 9, 2011**

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This document is a collection of thoughts and suggestions for the DOE energy literacy document. This was produced largely during the San Francisco meeting of the DOE energy literacy workgroup on March 8, 2011.

What we have not had the opportunity to do in this document is to go through the ‘proxy’ energy literacy document presented at the SF meeting and modify all of the detailed points under the broader taxonomy.

Another thing we would like to do is propose a ‘matrix’ structure for the energy literacy document where core physical principles are one axis, and the other axis is all of the entry points by which those core principles might be illustrated. This might enable the wedding of ‘prosaic’ and ‘colloquial’ versions of what it means to be ‘energy literate’. Consider it ‘energy literacy for the top tier college track student’ and ‘energy literacy for the blue collar track student’.

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## 1 What does it mean to be energy literate?

- To be energy literate means that you understand conceptually the basic flows of energy through earth's systems including human use.
- To be energy literate means being able to understand the contribution of your own personal actions (how you use energy) in the context of the larger scale society you live in (state / nation / globally).
- To be energy literate means being able to critically assess any general news item about energy issues. This means being able to intuit whether the scientific or engineering principles covered in the news item, and the claims about them, are 'reasonably correct'.
- Being energy literate means being capable in a democratic society of voting cognizant of the impacts of collective energy choices.

*...Or we could state the energy literacy in far less prosaic and more practical terms:*

- To be able to contextualize the quantities on your utility bills.
- To understand the proportionality of the various energy uses in your life.
- To understand the proportionality of global / national / regional power supply.
- Unit conversation including converting between power and energy.
- Understand link between energy supply, demand, and climate change.

## 2 Why should we care about energy literacy?

The way we use and produce energy effects our environment, and our economics, at personal, local and global scales. Climate change is a product of the way we use and produce energy. National economies are tied to the way they use and produce energy and this influences notions of 'energy independence'.

## 3 Science fundamentals that should be covered

- 1st law
- 2nd law
- 3rd law
- Heat engines
- Heat capacity
- Chemical energy

n.b. This could be taught in terms of gradients and flows.

## 4 Existing Taxonomy of Energy Literacy

1. Energy is a measurable quantity that follows physical laws.
2. Energy from the Sun, (which is fusion energy) is the primary source of energy for the Earth System.
3. Energy transfers and transformations are central to all living organisms and ecosystems.
4. Various sources of energy can be used to power human activities and often this energy must be transferred from source to destination.
5. The amount of energy human society uses depends on many factors and can be reduced in many ways.
6. Use and access to energy resources is determined by laws and regulations, geographic location and socio-economics.
7. Different ways of obtaining, transforming and distributing energy have different impacts and consequences.
8. Individuals, communities, cities, states, nations, and the world, make energy decisions every day.

## 5 Alternative Taxonomies of Energy Literacy

There are core physical principles that are necessary for a deep understanding of energy. Energy conservation, 1st and 2nd laws, etc. These are often difficult counterintuitive notions that even mature physics graduate students can struggle with at some deep level. This might be called the 'prosaic' version of energy literacy. To avoid perfection being the enemy of the good, and to consider that the audience for energy literacy is broad, we might like to consider the type of energy literacy we'd like in students (and in fact all citizens), a literacy one might term the 'working energy literacy', or a 'colloquial energy literacy'.

Alternative taxonomies might be conceived to enable this.

For example:

1. How energy is used in your daily life, and how one can learn all the physics and science of energy by understanding the energy flow associated with daily activities like showering, driving, electricity, food, and heating or cooling your home.
2. How energy is used across a population at state / national / global scale, and the sources and flows of energy in the national or global picture. Again, most physical principles about energy can be illuminated through this 'lens'
3. How energy flows in natural systems.

## 6 Big Ideas (broken into detail)

### 6.1 You can understand your own life and lifestyle in terms of the energy you consume

I think leading with the fundamental concept that you can understand everything you do in your life in terms of energy is a democratizing access point for creating an energy literate citizen.

## **6.1.1 Contribution of transporting yourself**

- flying
- driving
- trains
- bicycles
- walking

## **6.1.2 Contribution of feeding yourself**

- Growing the food
- Fertilizing soil
- Transporting food
- Packaging food
- Cooking food
- Refrigerating food
- Disposing of waste food

## **6.1.3 Contribution of sheltering yourself (housing)**

- Building the house
- Heating the house (including insulation concerns)
- Cooling the house
- Lighting the house
- Powering electronic devices in the house

## **6.1.4 Contribution of your consumer life-style**

- Making the stuff
- Powering the stuff
- Disposing of the stuff

## **6.1.5 Contribution of being a member of society**

- Your role in society
- How society (through taxes) uses energy
- Military
- Government
- etc...

# Energy Literacy

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## 6.2 The principles of physics allow a complete understanding of energy

Existing energy literacy document taxonomy categories are highlighted in RED

6.2.1 There are fundamental laws learned by science that are our mechanisms for understanding energy and energy flows. *This could be used to talk about the history of what we know and don't know about energy / thermodynamics.*

6.2.2 Energy and energy flows are fundamental to all of the physical sciences (physics, biology, chemistry, etc...)

6.2.3 **Energy is a measurable quantity that follows physical laws.**

- The total amount of energy in the universe is constant. Energy is transferred by chemical, nuclear, light and other radiation based processes.
- As energy is transferred between systems, the systems become more disordered. (This is known as Entropy.) The total amount of matter and energy is conserved (remains precisely the same).
- The efficiency of an energy conversion system is the ratio of the energy input to a system divided by the *useful* energy output. All energy conversion systems have known maximum efficiencies.
- In any energy conversion or transformation some energy is dissipated into the environment, most typically as heat. Practically speaking this is why we talk about "using energy up"
- The flow of energy is predictable, such as from hot objects to colder ones.
- Chemical reactions may release or consume energy. Energy can be stored in chemical bonds and released later through a chemical reaction.
- Not all forms of energy are equally useful.
- There are many units with which to measure energy or power. Energy is a quantity, power is the rate at which we use energy. It is possible to convert between all of the different energy and power units to make meaningful comparisons.

6.2.4 **Energy from the Sun, (which is fusion energy) is the primary source of energy for the Earth System.**

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- 6.2.5 **Energy transfers and transformations are central to all living organisms and ecosystems.**
- 6.2.6 **Various sources of energy can be used to power human activities and often this energy must be transferred from source to destination.**
- 6.2.7 **The amount of energy human society uses depends on many factors and can be reduced in many ways.**

## 6.3 History and Future of Energy Supply and Demand

- 6.3.1 **Use and access to energy resources is determined by laws and regulations, geographic location and socio-economics.**
- 6.3.2 **Different ways of obtaining, transforming and distributing energy have different impacts and consequences.**
- 6.3.3 **We can understand the energy situations we are in by looking at the history of energy use.**
- 6.3.4 **To think about the future of energy supply, we need to consider resource quantities, and rates of renewal.**
- 6.3.5 **Individuals, communities, cities, states, nations, and the world, make energy decisions every day.**

## 7 Things that are in danger of being missed...

### 7.1 Efficiency vs. efficiency...

A gross challenge to the public energy conversation is the misuse of the term 'efficiency'. It can very much mean two things, either the thermodynamic efficiency of a machine or a process, or the reduction of energy through changing behavior (driving less).

This confusion manifests itself as people believing they are making a big difference (by buying a more 'efficient' device, rather than make a REALLY big difference, by changing the way they do things).

I'm wary of words like conservation or any other word that might imply that behavior change is about denial or abstinence. It should perhaps be 'lifestyle choices' ?

What are the mechanisms within an energy literacy framework to fully tease out the difference between these things?

### 7.2 Systems Science / Systems Thinking

Energy is a systems problem and touches every aspect of life on earth. To understand energy comprehensively requires a working understanding of 'systems thinking'. How do we embed that in the foundational science skills for energy literacy.

### 7.3 Units and Unit Conversion

To be energy literate one needs to make meaningful comparisons between quantities of energy and power measured in wildly different units. Intuitive understanding of the basic units compared to personally meaningful quantities should be emphasized (eg. 100 Watts is a lightbulb is how much biochemical energy to run a human). A fluency in unit conversion between units, and between energy and power is

### 7.4 Proportionality

In the most colloquial sense, people think about things proportionally. Having said that, and probably due to the proliferation of different units, people don't have an intuitive sense of the proportionality of energy supply, or energy demand. If the lowest common denominator expectation of

energy literacy is an intuitive sense of energy, perhaps emphasis should be placed on merely the proportionality of energy demand and supply at the different scales of interest (individual, local, regional, state, national, global).

### **7.5 Time and history /future**

A very engaging entry point for energy issues is historical. Contemporary concern is about the future of energy. Both history and future are time dependent notions, and embedding in energy literacy the relative and pertinent timescales (geological, millennial, decadal, instantaneous) and what decisions effect which timescales is a very important notion.